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ENVIRONMENTAL MANAGEMENT AND BIOLOGICAL ASPECTS OF TWO ERIOPHYID MANGO MITES IN EGYPT: *ACERIA MANGIFERAE* AND *METACULUS MANGIFERAE*

Badawi A. ABOU-AWAD[1], Abdel-Satter METWALLY[1], Mahmoud M. AL-AZZAZY[2]

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[1] *Plant Protection Department, National Research Centre, 12622 Dokki, Cairo, Egypt.*
badawi_abou_awad@hotmail.com; abdelsattar_metwaly@yahoo.com
[2] *Department Agricultural Zoology and Nematology, Faculty of Agriculture, AL-Azhar University, Cairo, Egypt.*
dr_mahmoud_azzazy@yahoo.com

ABSTRACT — The mango bud *Aceria mangiferae* Sayed and the mango rust mite *Metaculus mangiferae* (Attiah) were studied for two years in an abandoned mango orchard in Egypt. The eriophyid mites were fed upon by two predatory phytoseiid mites *Typhlodromus mangiferus* Zaher and El-Borolossy and *Typhlodromips swirskii* (Athias-Henriot). Population abundance of the eriophyid mango prey were affected by climatic conditions, predation, shady and sunny zones and vertical distribution. A control measure of one winter acaricides treatment, applied after budding, seemed to be the most successful management of the harmful mites. Higher temperature enhanced development of *A. mangiferae* and *M. mangiferae*. Some of the life table parameters varied greatly, especially at 25 °C and 60 % RH and 35 °C and 50 % RH. Field and laboratory studies indicated that viviparity is a typical character in the reproduction of *M. mangiferae*.

KEYWORDS — *Aceria mangiferae*; *Metaculus mangiferae*; mango; eriophyid; Egypt

INTRODUCTION

Eighteen species of eriophyid mango mites from different parts of the world are known, causing its vanishing and consequently the crops severely drop down (Amarine and Stasny 1994; Chandrapatya and Boczek 1991, 1997). The mango bud mite, *Aceria mangiferae* Sayed and the mango rust mite, *Metaculus mangiferae* (Attiah) are injurious in mango orchards in Egypt. Recently, infestations have increased to significant rates. The most familiar symptoms caused by these mites are rusting, bud blasting, impedence of new growth, bud distortion and leaf chlorosis. Severe flowering and vegetative bud infestations, stop growing and consequently other lateral buds grow up, yet they soon got infested. If such an infestation continuous for few successive years, young trees become stunted and do not developed normally. On the other hand, the pesticides used in mango orchards destroy the predacious mites, especially phytoseiids, which are most important in controlling the phytophagous mite species (Al-Azzazy 2005). Therefore, a great care is given to develop alternative methods of control to minimize the application of pesticides and get chance the biological control against mites through integrated pest management strategies. The aim of this study is to find out an effi-

cient control method based on ecological approach. The different biological aspects of the life history of mango bud and rust eriophyid mites were also studied for the first time.

MATERIALS AND METHODS

Ecological studies of the mango bud mite *Aceria mangiferae* Sayed and the mango rust mite *Metaculus mangiferae* (Attiah) and their predators (*Typhlodromus mangiferus* Zaher and El-Borolossy, *Typhlodromips swirskii* (Athias-Henriot) were carried out in abandoned mango orchard (*Mangifera indica* L.), 13 years old, in Cairo, for the two years 2003 and 2004. In order to provide comparative measures of the eriophyids and their predacious mites under different conditions, ten mango trees, Alphonso cultivar of similar size, vigor and shape were selected. Samples of 25 leaves and ten of both lateral and terminal buds were taken at random every week. *M. mangiferae* and predatory phytoseiid mite populations were estimated by examining leaf surfaces. Buds were cut to their leaf scales and examined to assess numbers of *A. mangiferae* and *M. mangiferae*. Eriophyids occurrence were also recorded by examining samples of 25 leaves and five of both terminal and lateral buds of the sunny terminal parts of the shrub branches and another from the shady central core of the same cultuvar shrubs, regularly every other week during summer months. To study the comparative abundance of leaf surfaces, terminal and lateral buds and vertical distribution of *A. mangiferae* and *M. mangiferae*, 60 leaves, 15 lateral and 15 terminal buds were collected randomaly from top, botton and middle of Alphonso cultivar. Observations were made for two years, from January to December. Samplings were performed on the 15th of every month. In the present investigation, leaves and buds of mango trees from the upper 80 – 100 cm of the branches, represented the "top-level" while those on the branches of the trees up to a height of 150 – 200 cm above ground level, represented the "bottom-level". The foliage and buds between the top and the bottom level were regarded as "middle-level".

Treatments

An area of the same abandoned Alphonso mango trees, with a history of eriophyid mite infestations was selected. Abamectin (Vertimec 1.8 % EC at the rate of 27 oz., 794 g/ha), Chlorfenapyr (Chalenger 26 Sc at the rate of 34 oz., 955 g/ha), Methoxyfenozide (Runner 24 % SC at the rate of 68 oz., 1910 g/ha), Azadirachtin (Achook at the rate of 135 oz., 3820 g/ha) and Sulphur (Micronized sulpher 99.8 % at the rate of 169 oz., 4775 g/ha) were applied. Treatments were carried out when eriophyid mite populations started to increase. Each treatment was replicated four times and each replicate consisted of two mango trees. Treated and untreated replicates were represented each by 25 leaves and 10 buds. Pre-spray counts were made for all treatments and replicates to determine the initial distribution and density of the mites. Observations were made one, three days and eight weeks post treatments. Reduction percentage was estimated according to the formula of the Henderson and Tilton (1955). Spray was applied with a conventional high pressure spray motor and hand spray gun.

Life history study

The method described by Abou-Awad *et al.* (2005) for rearing the eriophyid mites was followed to study mite biology. A medium consisted of agar 8 gr., murashige and skoag 1.1 gr., rose Bengal 1 gr. and indol acetic acid 1 ml solved in distilled water 1000 ml. Agar was transferred to a vial and was melted using a boiling water-bath, then a vial was removed. Murashige and skoage was agitated in the melted agar till dissolved. The obtained mixture was then sterilized by adding rose bengal which was dissolved by agitation. Indol acetic acid was added to the dissolved mixture.

Soft terminal mango branches with terminal buds of 15 – 20 cm were washed and all attached leaves were removed for each branch to rear the mango bud mite *A. mangiferae* between outer of first and second bracts of the terminal bud. Soft lateral mango branches were also washed and divided into parts of 12 – 15 cm length and attached leaves were

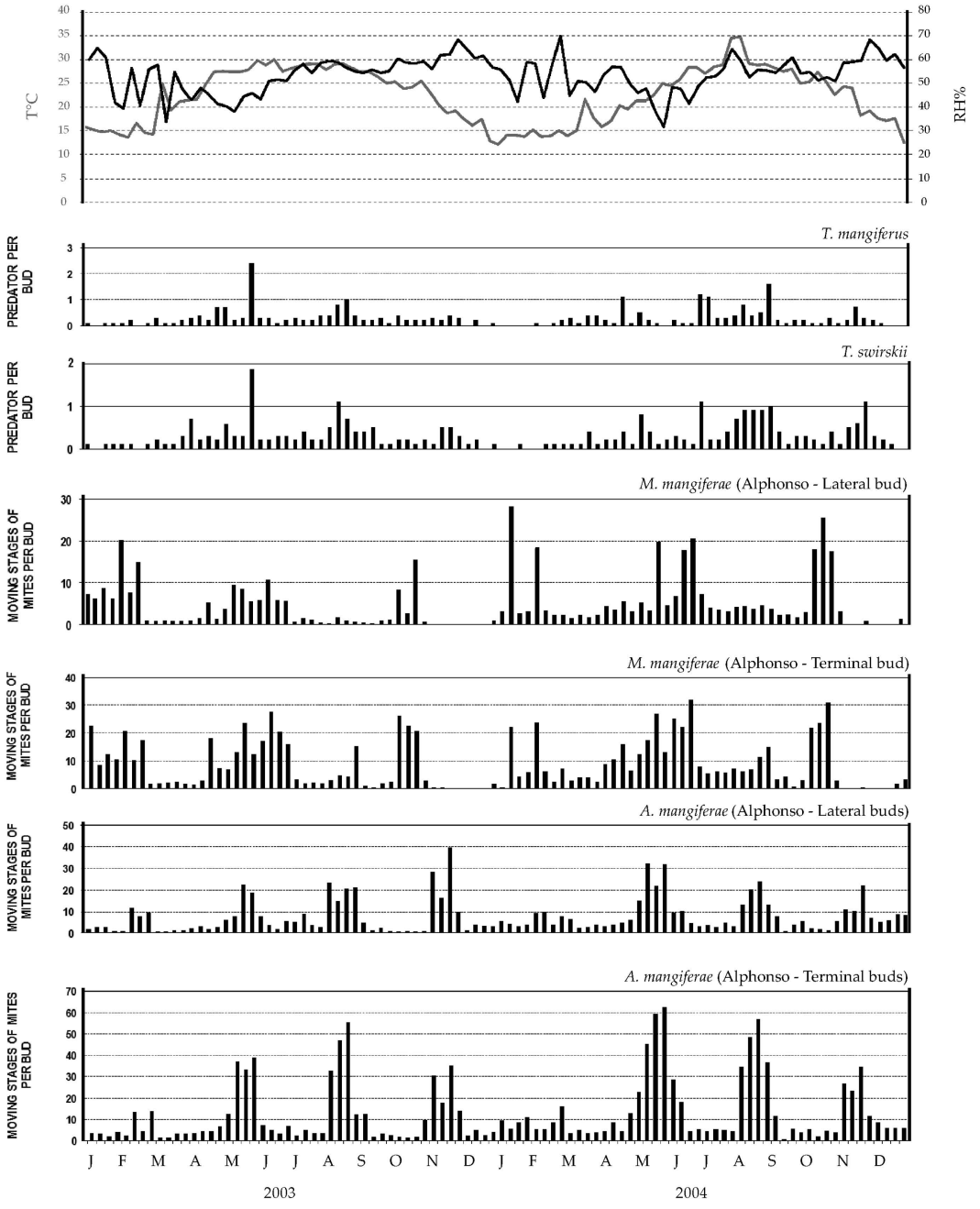


FIGURE 1: Population trends of eriophyids and their predatory mites associated with mango trees in relation to temperature and relative humidity over a two-year period (2003-2004).

removed, except one succulent leaf was left for each part of the divided branches to rear the mango rust mite *M. mangiferae*. Cuttings of each group were dipped, for two seconds, into indol acetic acid to encourage developing roots, before inserting into tubes contained the above-cited prepared medium. Thirty new adult stages of mango buds and leaves were placed singly between outer bracts of the ter-

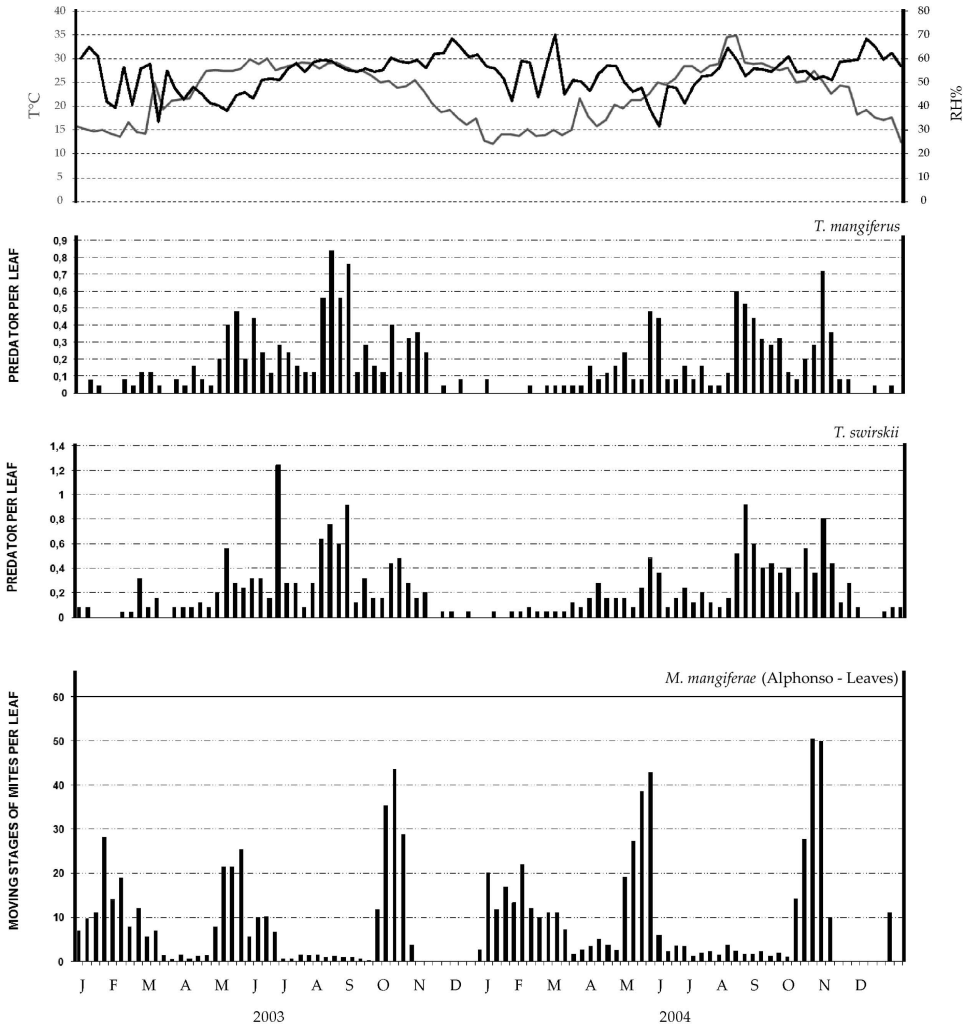


FIGURE 2: Population trends of the mango rust mite, *Metaculus mangiferae* and the phytoseiid predators on Alphonse mango leaves in relation to temperature and relative humidity over a two-year period (2003-2004).

minal buds or on the surface of the rearing attached leaves. Each female was allowed to deposit 1 – 2 eggs (*A. mangiferae*) or 1 – 2 first satge larvae (*M. mangiferae*), then removed. Tables were placed in the incubator and development of mites was observed twice daily.

Insemination took place soon after male and female emergence, each newly virgin female was transferred for 24 h, to a leaf or outer bract of bud previously inhabited by an adult emerged male, to allow insemination by spermatophores, then females and males were transferred back to their previous substrates.

Experiments conducted under conditions of 25±1 °C and 60 % RH, 30±1 °C and 55 % RH and 35±1 °C and 50 % RH and 12/12 h light/dark. Adult stages of the predacious mites were mounted in Hoyer's solution, as modified by Schuster and Pritchard (1963), for identification. Adult stages of *M. mangiferae* were mounted twice weekly in Keifer's (1954) solutions during the two successive years to observe the males, pre-oviparous, oviparous, ovoviviparous and viviparous females. Records of the daily temperature and relative hu-

midity, prevailing at the locality and corresponding to sample periods, were taken from the Central Meteorological Department, Ministry of Scientific Research. Life table parameters were calculated according to a Basic computer program (Hulting textitet al. 1999).

Results and discussions

Seasonal variations

The population dynamics of eriophyids and their predatory mites for a 2-year study on the mango trees (cv. "Alphonso") and weather records are presented in figures 1 and 2.

Eriophyid mites

Two injurious mites were commonly found on the mango trees: the mango bud mite *A. mangiferae* and the mango rust mite *M. mangiferae*. The former mite was the most prominent in terminal and lateral buds, while the latter came second in the order of abundance in buds and on leaves. Mite species were described from Egypt by Sayed (1946) and Attiah (1955), respectively. *A. mangiferae* stunts and induces witches broom, causing bud proliferation; it was slow in both effect and motion and weakened the terminal buds and consequently many lateral buds around it grew up forming a stunting appearance. *M. mangiferae*, on the contrary, was much more active and caused a quicker effect on the vegetative bud which dried without producing any lateral buds, and in high infestation, leaves become curled and ruled around its self. Three annual peaks of seasonal abundance on Alphonso cultivar were recorded (Figure 1). The first peak of *A. mangiferae* occurred in late or in third and mid May recording 39 and 63 or 23 and 32 individuals per terminal or lateral bud during the two successive years 2003 and 2004, when temperature and relative humidity averaged 27.94 °C and 45.75 % and 25.03 °C and 31.66 % or 27.42 °C and 44.45 % and 21.31 °C and 47.82 %, respectively. The second peak was noted in third or in first and third August and recorded 55 and 57 or 23 and 39 individuals per terminal or lateral bud, when temperature and relative humidity averaged 29.18 °C and 56.73 % and 28.80 °C and 55.75 % or 27.86 °C and 59.22 % and 28.28 °C and 55.75 %, respectively. The third peak occurred in third November recording 34 and 35 or 40 and 22 individuals per terminal or lateral bud, when temperature and relative humidity averaged 18.37 °C and 62.06 % or 18.31 °C and 59. 75 %, respectively. However, Zaher and Osman (1970) recorded two annual population peaks on Timour cultivar in Egypt, one was usually in February and the other in September. These peaks might occur one or two weeks earlier or latter depending on climatic conditions, time of budding and the new growth cycle in fall.

The distribution of *M. mangiferae* in buds differed from that of *A. mangiferae*. Three annual peaks of seasonal abundance were also observed (Figure 1). The first peak occurred in early January 2003 or early February 2004 and early February 2003 or mid January 2004 for both terminal and lateral buds with 23, 24 and 20, 28 individuals per bud, when temperature and relative humidity averaged 15.9 °C and 60.11 %, 15.53 °C and 58.31 % and 14.19 °C and 39.50 %, 14.40 °C and 51.50 %, respectively, the second in mid and third June during two years for terminal and lateral buds with 28.32 and 11.20 individuals per bud, when temperature and relative humidity averaged 28.80 °C and 51.10 % and 28.40 °C and 41.34 % respectively, while the third peak occurred in early and third or in third and mid October With 26.31 and 15.26 individuals per bud, when temperature and relative humidity averaged 25.39 °C and 60.14 %, 25.31 °C and 52.27 % and 24.16 °C and 58.40 %, 27.37 °C and 51.18 %, respectively. It had been noted that the terminal flowering buds always tend to harbour a higher significant motile stages of eriophyid bud and rust mite populations than the lateral ones. Flowering buds, however, were considered to be the source of infestation for the new terminal buds of the new year. Therefore, it could be concluded that infestation of the mango bud mite had a negative relationship with that of the mango rust mite, as the former increased in May, August and November while the latter increased during January – February, June and October. In March and December, the population suddenly decreased.

TABLE 1: The correlation coefficient between temperatures, relative humidity and eriophyid mite populations in abandoned mango orchard (2003-2004).

Eriophyid mites	Correlation coefficient values											
	2003 season						2004 season					
	Temperature			Relative humidity			Temperature			Relative humidity		
	Leaves	Buds		Leaves	Buds		Leaves	Buds		Leaves	Buds	
		Terminal	Lateral		Terminal	Lateral		Terminal	Lateral		Terminal	Lateral
lAceria mangiferae		0.288	0.150		0.007	0.144		0.267	0.159		0.285	- 0.349
Metaculus mangiferae	0.137	0.133	0.148	- 0.166	- 0.278	- 0.368	0.119	0.212	0.117	- 0.447*	- 0.423	- 0.331

* Significant at 5% level

On leaves, the population density of *M.mangiferae* recorded three annual peaks. The first peak occurred in late January 2003 and early February 2004, the second in late May 2003 and 2004, while the third peak, which was the highest, occurred in third October 2003 and 2004 (Figure 2). During these annual peaks, the mean of mite population recorded 28 – 22, 26 – 43 and 44 – 51 individuals per leaf,when temperature and relative humidity ranged between 15.05 °C and 27.94 °C and 31.66 and 58.40 %, respectively. The population was positively correlated with prevailing temperature for two successive seasons, while no significant correlation was noted with the relative humidity (Table 1). The data obtained are in agreement with those reported by El-Banhawy (1973) and Abou-Awad *et al.* (2000).

To determine the number of annual generations of *A. mangiferae* and *M. mangiferae* under the local environmental conditions, the percentage of immature stages was estimated weekly. The time at which the highest percentage of the immature stages occurred represented the beginning of a new generation. About 16 and 17 generations for *A. mangiferae* were recorded during the two successive years, respectively. The longest generation was that which passed throughout spring and fall and lasted for about five and six weeks; the short generation occurred in winter and summer and lasted for about two weeks intervals during the two years. As to the mango rust mite, about 12 – 16 and 11 – 13 generations were annually recorded for both buds and leaves during the two successive years, respectively. The longest generation was that which passed throughtout February – March and March – April or April – May and lasted for about 35 – 49 days during 2003 – 2004 for both buds and leaves, respectively, while the shortest generation was similar to the mango bud mite.

A great difference was noted between numbers of motile stages of *A. mangiferae* and *M. mangiferae* on buds and leaves of sunny and shady zones during the two summer seasons of 2003 and 2004 (Figures 3, 4). The central cores always tend to harbour a higher significant mite population than the sunny terminal zones, either buds or leaves, during June, July and August. This phenomenon could be due to the preference of eriophyid mango mites to the shady zones seeking shelter against heat during the summer season. Abou-Awad *et al.* (2000) revealed that the shady buds and leaves harbour an almost equal population of the eriophyid fig bud mite *Aceria ficus* (Cotte) and the eriophyid fig leaf mite *Rhyncaphytoptus ficifoliae* Keifer as the sunny ones, but the reverse was observed for the two spotted spider mite *Tetranycus urticae* Koch.

The numerical changes in vertical distribution of the eriophyid mites *A. mangiferae* and *M. mangiferae* on Alphonso mango trees for two successive years, with temperatures and relative humidites for the corresponding period are given in Figures 5, 6 and 7. Tracing up the population trend of *A. mangiferae*, it was found that its density exhibited a gradual increase and decrease from February reached its peak during May, October 2003 and May and August 2004, then strated declining from November onwards. At the top level, terminal and lateral buds had significantly more numbers of mango bud mite, especially terminal ones, in comparison to the middle and bottom levels (Figure 5); while the population of the mango rust mite *M. mangiferae* started in April or May and gradually increased till it reached

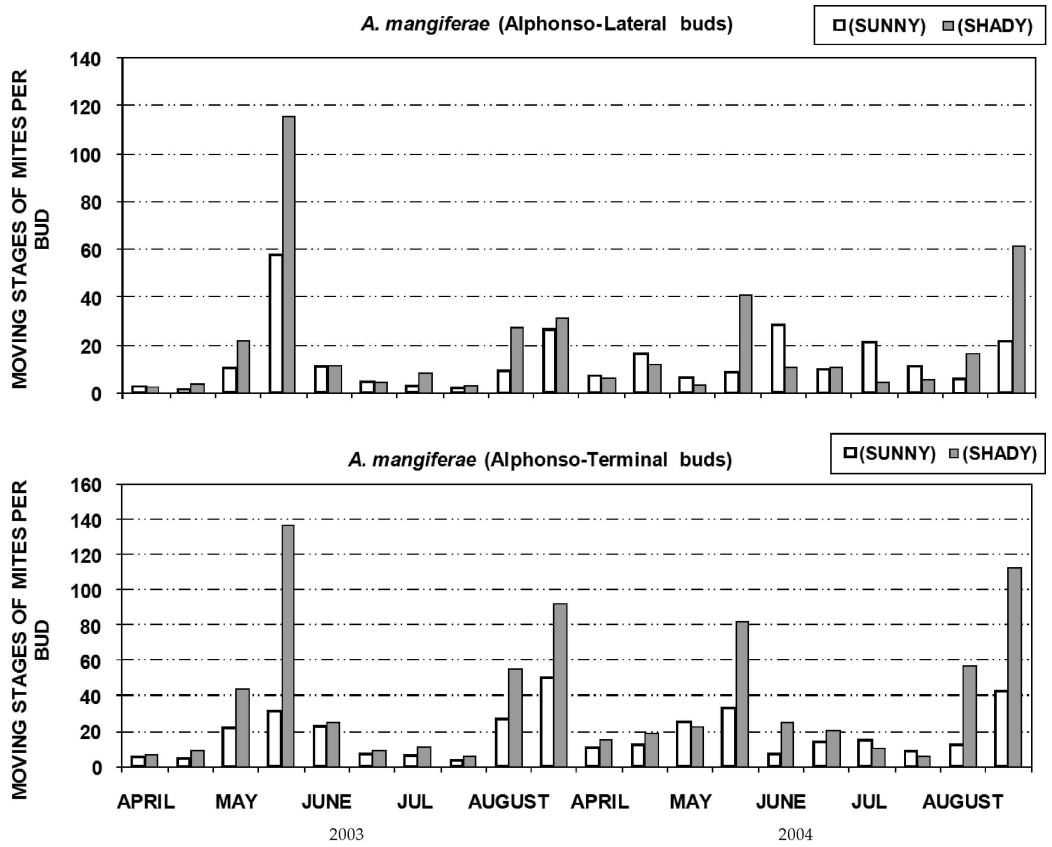


FIGURE 3: Population density of *Aceria mangiferae* on terminal and lateral buds of sunny and shady zones of Alphonse mango trees during summer seasons in abandoned orchard.

peak in June for both buds and leaves and fluctuated declining from July to October, when it tailed off in November and December during two successive years (Figures 6, 7). Comparative study among different levels showed that the rust mite density was significantly high in the lateral buds in comparison to the terminal ones. At the bottom level, buds had relatively less numbers of mites in comparison to the top middle levels. Its individuals preferred hibernation under scale leaves of the vegetative buds in the period extended from end October to december. At the beginning of the growing season in January and February, noticeable number of the first instar nymphs were noted in swollen vegetative buds. These buds were the main source of infestation for new leaves in spring and fall. Density of the mango rust mite on the upper and lower leaf surfaces at the three vertical levels demonstrated that its distribution was significantly high on the upper leaf surfaces, especially the top level (Figure 7). The data suggest that aforementioned preferred sites to mango eriophyid feedings are useful for sampling of the mite populations to evolve suitable strategies for the applications of chemical control.

Predacious mites

Eriophyoid mites have recently become very important acarine pests infesting fruit trees. In nature, these acarine pests are only a part of biological complex of which predacious mites, particularly phytoseiid group, could be of practical economic value in checking their infestations. Several workers have reported that phytoseiids have a role to play in the control of these noxious acarine pests (e.g. Burrel and McCormick, 1964; McMurtry *et al.* 1970;

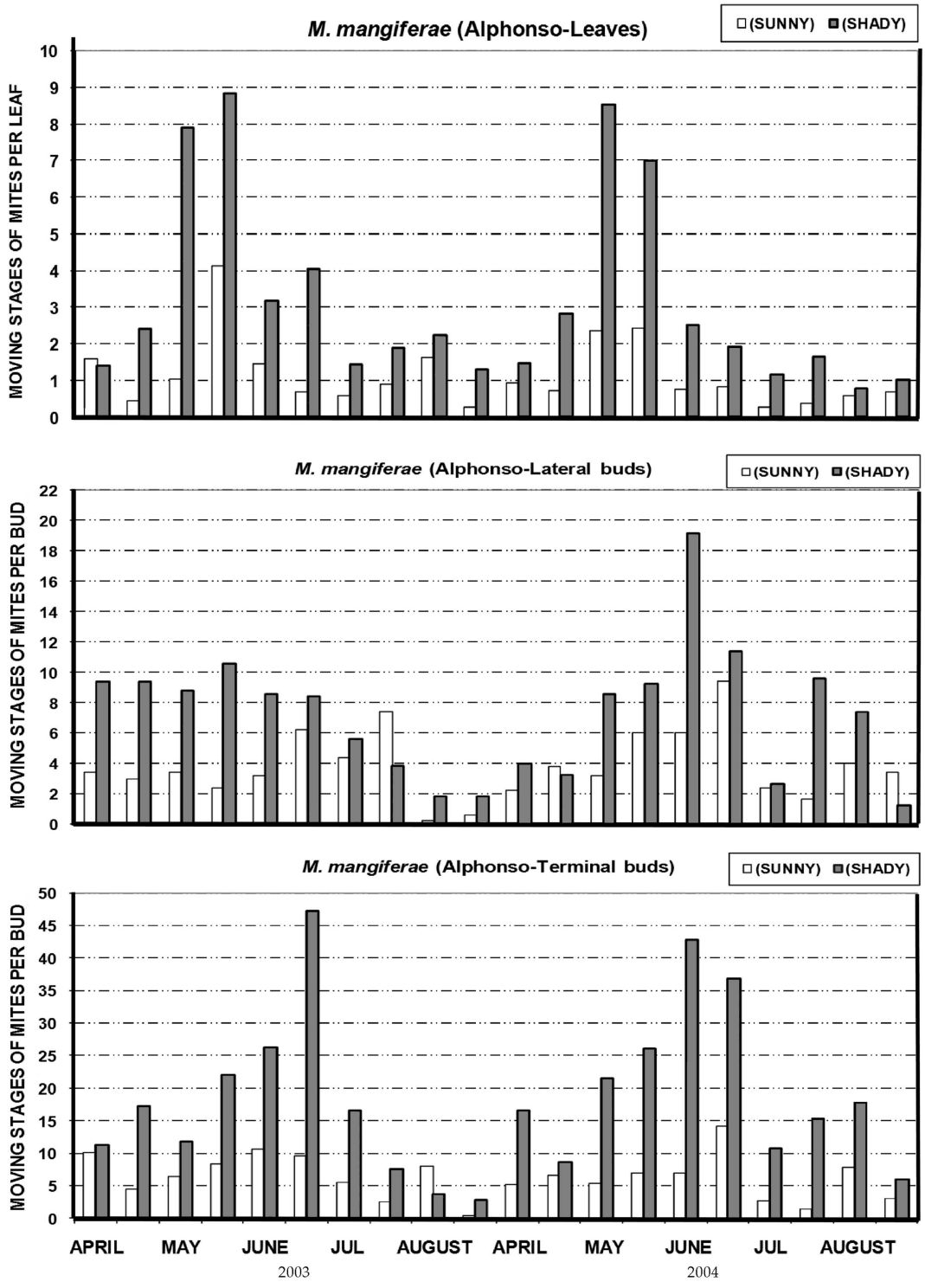


FIGURE 4: Population density of *Metaculus mangiferae* on terminal and lateral buds and leaves of sunny and shady zones of Alphonse mango trees during summer seasons in abandoned orchard.

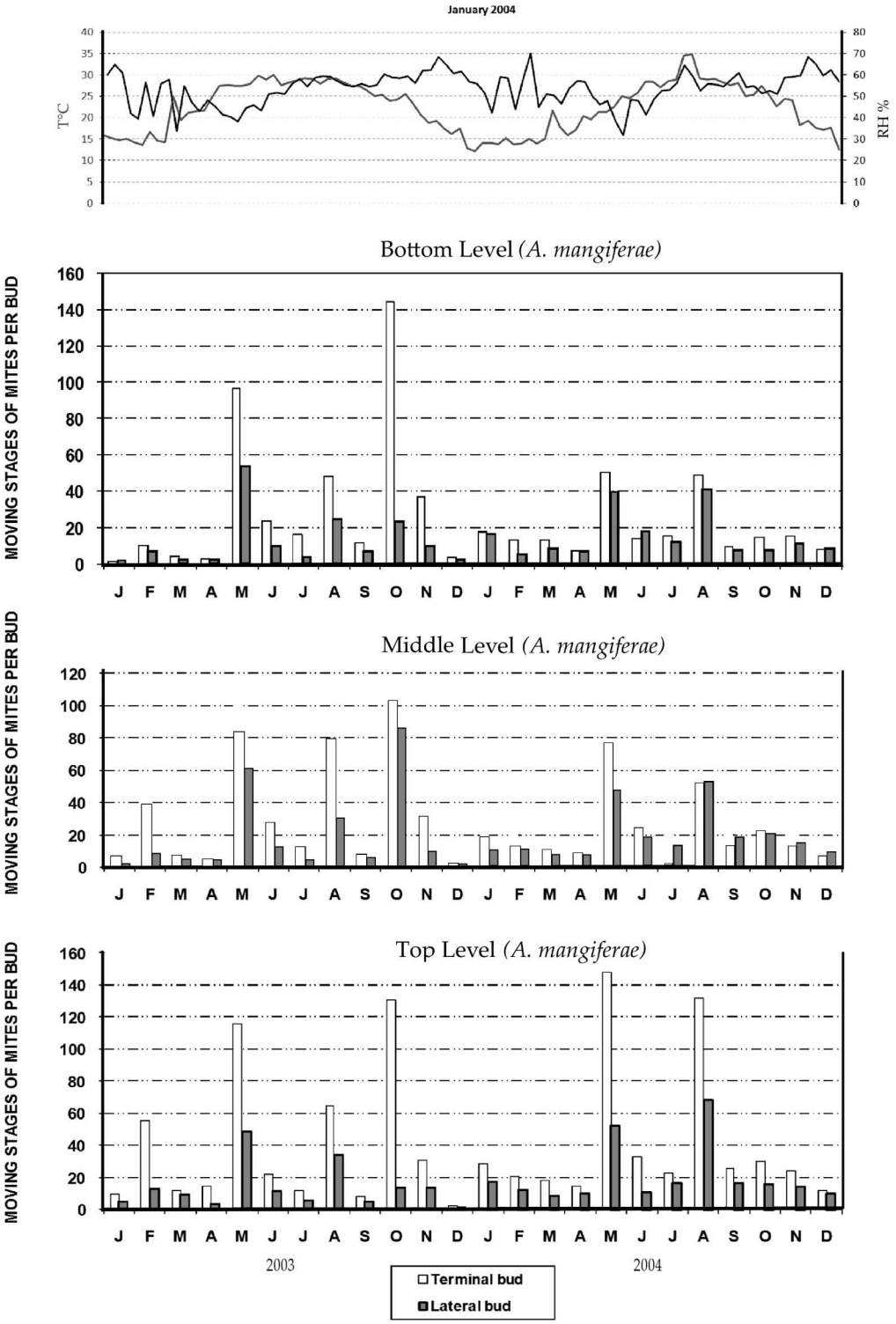


FIGURE 5: Population trends of, *Aceria mangiferae* on terminal and lateral buds of Alphonse mango trees in abandoned orchard from January to December and weather records.

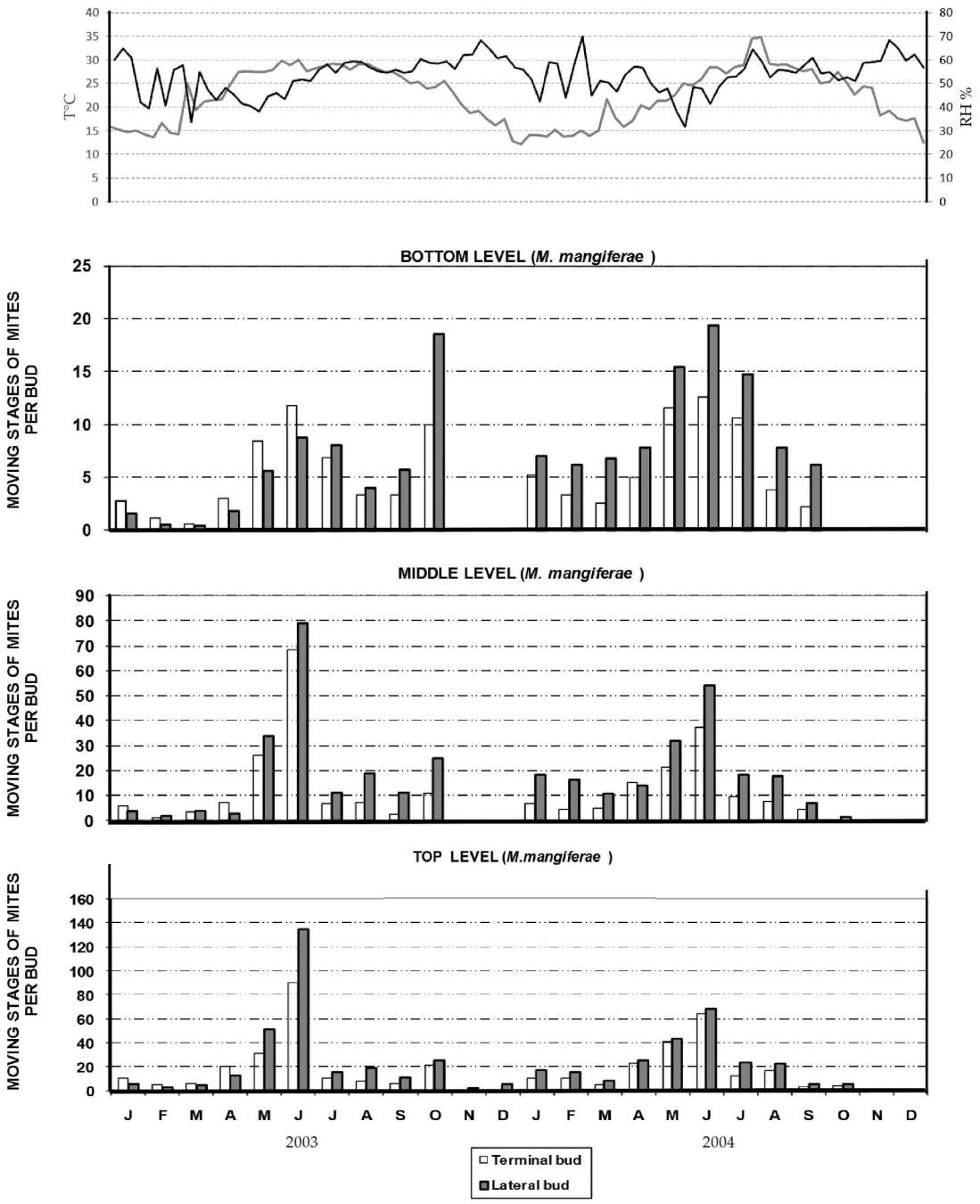


FIGURE 6: Population trends of, *Metaculus mangiferae* on terminal and lateral buds of Alphonse mango trees in abandoned orchard from January to December and weather records.

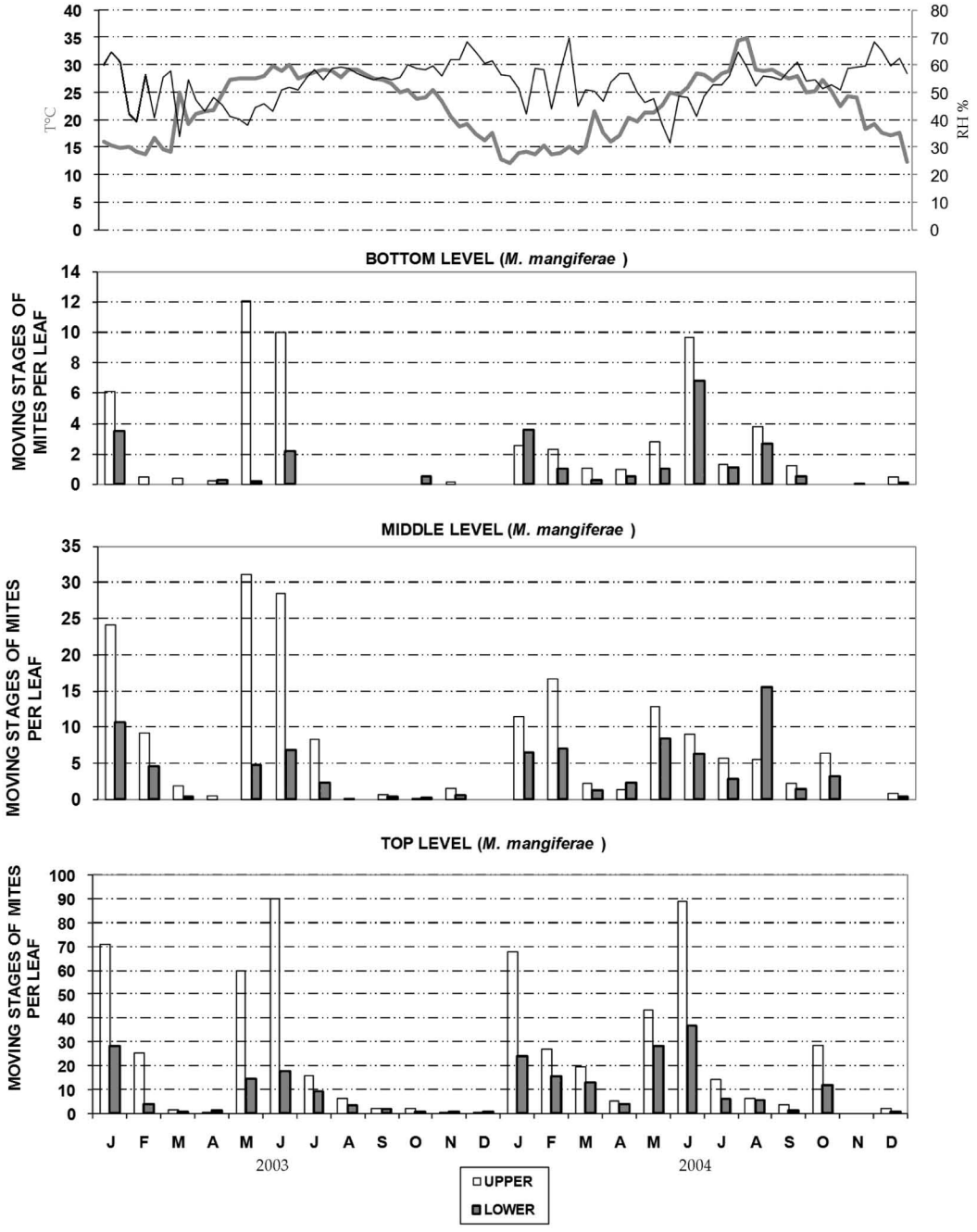


FIGURE 7: Population trends of, *Metaculus mangiferae* on upper and lower leave surfaces of Alphonso mango trees in abandoned orchard from January to December and weather records.

Amano and Chant 1986 ; Abou-Awad *et al.* 1989; Sano Soo and Palk 1999; Rasmy *et al.* 2003). Therefore, it was interest to study the population dynamics of phytoseiid predators during the two successive years 2003 and 2004. The general trends in the occurrence and the abundance of the predator mites *T. swirskii* and *T. mangiferous* are given in Figures 1 and 2. *Typhlodromips swirskii* was the most predominant in Alphonso orchard and was found in 85 % of bud and leaf samples containing predators. *Typhlodromus mangiferous* came second in the order abundance forming 81 % of the total samples. Their population density began to increase in April, then fluctuated till reached a peak in August, then tailed off in December. A positive relationship was noted between the incidense of the two eriophyid mango mites and two predators on the same buds and leaves. These facts indicate that eriophyid prey probably play an important part of the predator diet. The data are in accordance with those reported by Baker (1939) and Abou-Awad *et al.* (2000).

It can be concluded that the population dynamics of eriophyid mites on abandoned mango trees were affected by prevailing climatic conditions and action of predatory – prey relationship. However, it is difficult to sort out the precise reasons for fluctuations of these predacious mites and their relative numbers because of the complexities involved in the multiple predator – prey relationships. Phytoseiid species such as *Amblyseius hibisci* (Chant) (McMurtry *et al.* 1970) and *A. swirskii* Athias-Henriot (Abou-Awad *et al.* 2000) are reported to utilize eriophyids as a food source, but they do not reduce them satisfactorily, due to they do well on tetranychid species, such as *Tetranychus urticae* Koch, which produce heavy welling (McMurtry and Scriven, 1964).

Pesticides management of mite populations

It is widely accepted that pesticides have adverse effects on human health, plant, environment and all sorts of animal life. The population studies of the predacious mites and eriophyid mango mites revealed the predatory phytoseiid mites *T. mangiferus* and *T. swirskii* were almost absent or present in very low numbers after budding in early February (2005), and are ineffective in reducing the populations of the mango bud mite *A. mangiferae* and the mango rust mite *M. mangiferae* below the economic injury level. Thus, one application of safe compounds in early February, when eriophyid populations started to increase, was sufficient to sppress the mite populations for the entire year. This also allowed for the longest possible period of the biological control.

Table 2 shows the effect of some acaricides or pesticides on eriophyid mango mites during the second season (2005). The results indicate that abamectin is a promising control against eriophyid mango mites. It caused a reduction of 95 % and 97 % or 98 % in the populations of *A. mangiferae* and *M. mangiferae* on buds or leaves, respectively during the 35 days following applications, followed by chlorfenapyr, then sulphur. Methoxyfenozide and azadirachtin ranged the less effective pesticides. Similar effects of abamectin against eriophyid mites were found on fig, olive and mango trees in Egypt (Abou-Awad *et al.* 2000) and on citrus in Florida (Childers 1986). It is also slightly toxic by contact predacious mites (Grafton-Cardwell and Hoy 1983; Hoy and Cave 1985; Reda and El-Banhawy 1988). Many authors (such as Whitehead *et al.*, 1978; Ball 1982; Easterbook 1984; Abou-Awad *et al.* 2005 and 2009) have revealed that if spray could be eliminated, or at least greatly reduced, orchard mites would not be a problem.

Biology

The mango rust mite, Metaculus mangiferae *(Attiah)*

Eriophyoid mites are usually oviparous. Sometimes, the egg may start to cleave, and embryo may develop into a first stage larvae which hatches inside female's body as an ovoviviparous reproduction. This reproductive behaviour has been reported by several workers (Nalepa 1889; Boczek 1961; Shevtschenko 1961; Hall 1967, Jeppson *et al.* (1975); Briones and McDaniel 1976; Abou-Awad 1981; Delillo 1991). On the other hand, viviparity is observed in *Aculus uleae* Boczek and *Rhyncaphytoptus ulmivagrans* Keifer (Channabasavanna 1966) and in *Rhyncaphytoptus ficifoliae* Keifer (Abou-Awad

TABLE 2: Acaricides effect on the eriophyid mango mites in the Cairo orchard within 35 days after application treatments in 2005 season.

Acaricides	Concentration %	Pre-spray count	Average Post-spray count*	Reduction**%
		Number of *A. mangiferae* /bud		
Abamectin	0.04	10.95	0.45	95.4 a
Chlorfenapyr	0.05	11.17	1.05	89.6 b
Metoxyfenozide	0.10	11.60	1.32	89.1 b
Sulphur	0.25	12.30	1.35	87.8 b
Azadirachtin	0.20	12.32	2.22	78.9 c
Control	---	12.50	11.22	---
		Number of *M. mangiferae* / bud		
Abamectin	0.04	10.75	0.22	97.8 a
Chlorfenapyr	0.05	12.05	0.85	93.4 b
Metoxyfenozide	0.10	11.90	1.22	90.6 b
Sulphur	0.25	10.57	1.20	89.3 c
Azadirachtin	0.20	11.12	1.47	88.2 c
Control	---	11.00	11.40	----
		Number of *M. mangiferae* /leaf		
Abamectin	0.04	14.27	0.10	98.2 a
Chlorfenapyr	0.05	14.42	1.47	87.3 b
Methoxyfenozide	0.10	14.17	2.37	75.6 c
Sulphur	0.25	11.02	0.82	89.1 b
Azadirachtin	0.20	13.87	2.17	77.1 c
Control	---	14.10	9.77	----

* Counts made 1, 3 days and 5 weeks post treatment.

** Mortality values calculated with Henderson-Tilton equation

Different letters in vertical column denote significant difference (F -test, P<0.05, P<0.01).

et al. 2000). However, the present ecological and biological studies revealed that *M. mangiferae* is a viviparous form, lacking the egg stage. This is confirmed by the females mounted on slides, during either population dynamic studies or laboratory rearing. Mounted females did not have eggs or chorion residues inside their bodies. Thus, viviparity is a typical character in the reproduction of the mango rust mite *M. mangiferae*. It is of interest to note that, no work has been carried out on the life-history, except little information about its life cycle by Abou-Awad (1981a).

Females produced their living young or larvae singly along the viens. Larvae were very small, worm like (not fusiform-like), translucent,135 – 139 μm long, fastened to the plant surface and motionless. After some hours they moved and became able to obtain nourishment. Each female produced 1 – 3

first stage larvae daily and sometimes stopped for 1 – 2 days before starting production again. The second larvae do not resemble the first stage ones. It is microscopically small, 176 – 184 μm long, fusiform, dorsally flattened and slight yellow in colour. It was noted that during the quiescent stages, the individual stretched its legs directly forward parallel to each other, and the mite fastened its self slightly at any site of the leaf surface. Moulting process was described by Abou-Awad *et al.* (2000) and it is usually in common with other species of the family Eriophyidae.

The female life-cycle lasted 6.29, 4.90 and 4.44 days at 25, 30 and 35 °C, respectively, while the male developed faster (Table 3). Insemination took place soon after female emergence from the last quiescent stage. It was noted that the mating process was essential for the maximum reproduction of the females, as unmated females produced lower numbers of larvae compared to mated ones. The female gave birth to an average of 20.53, 24.50 and 32.20 larvae, during a reproduction period that averaged 15.93, 17.40 and 17.06 days, and then survived for 5.40, 3.08 and 3.60 days before death at the previous temperatures, respectively. Reproduction period was the shortest at 25 °C and 60 % RH, while it was the longest at 30 °C and 50 % RH. The reverse took place with the female and male life span periods (Table 3).

TABLE 3: *Aceria mangiferae* and *Metaculus mangiferae* average duration (in days) and oviposition in controlled conditions (T°C., R.H., 12/12h. light/dark periods).

Mite stage	Sex	A. mangiferae Mean ± S.D.			M. mangiferae Mean ± S.D.		
		25 °C / 60 % R.H.	30 °C / 55 % R.H.	35 °C / 50 % R.H.	25 °C / 60 % R.H.	30 °C / 55 % R.H.	35 °C / 55 % R.H.
Egg	Female	4.30±0.33	3.36±0.17	2.82±0.09	----	----	----
	Male	3.68±0.24	2.91±0.16	2.58±0.24	----	----	----
First instar	Female	2.70±0.20	2.14±0.09	1.94±0.10	2.70±0.20	2.30±0.34	1.93±0.24
	Male	2.62±0.23	1.91±0.23	1.66±0.17	2.14±0.20	1.91±0.18	1.46±0.20
Quiescent larval	Female	0.24±0.10	0.25±0.11	0.26±0.11	0.33±0.14	0.25±0.01	0.22±0.01
	Male	0.25±0.11	0.22±0.11	0.25±0.12	0.27±0.11	0.23±0.12	0.21±0.09
Second instar	Female	2.15±0.33	1.93±0.24	1.65±0.11	2.90±0.29	2.08±0.20	2.06±0.19
	Male	2.37±0.24	1.83±0.19	1.08±0.20	2.50±0.20	1.91±0.17	1.84±0.17
Quiescent larva2	Female	0.29±0.13	0.26±0.17	0.27±0.10	0.36±0.16	0.26±0.10	0.23±0.10
	Male	0.25±0.10	0.25±0.11	0.24±0.11	0.29±0.10	0.22±0.13	0.22±0.09
Total	Female	9.68±0.21a	7.95±0.21b	6.94±0.10b	6.29±0.31a	4.90±0.23b	4.44±0.20b
	Male	9.20±0.19a	7.10±0.19b	5.81±0.20b	5.20±0.24a	4.27±0.33a	3.74±0.19ab
Pre-oviposition or - LP*	Female	4.76±0.33	2.85±24	2.35±0.20	4.20±0.20	2.40±0.17	2.80±0.20
Generation	Female	14.46±0.43a	10.81±0.20b	9.47±0.20b	10.49±0.33a	7.34±0.37b	7.24±0.33b
Oviposition or-LP*	Female	13.60±0.24	13.86±0.53	15.53±0.59	15.93±0.65	17.40±0.92	17.06±0.53
Total fecundity	Female	16.92±0.29a	19.92±0.35b	26.70±0.47c	20.53±0.33a	24.50±0.41b	32.20±0.29c
Post oviposition or LP*	Female	5.30±0.27	3.85±0.20	2.11±0.28	5.40±0.24	3.08±0.20	3.60±0.20
Life span	Female	33.34±0.3a	28.50±0.7a	27.11±0.6b	31.82±1.11a	27.80±0.83b	27.96±1.07b
	Male	30.70±0.3a	22.93±0.4b	24.00±0.06b	27.90±0.71a	25.70±0.66b	24.97±0.93b
% surviving	Female	100	100	100	100	100	100
	Male	100	100	100	100	100	100
Number of observations	Female	20	21	22	19	19	21
	Male	10	9	8	11	11	9

* Larval production

TABLE 4: Life table parameters of *Aceria mangiferae*, and *Metaculus mangiferae* , in controlled conditions (25, 30, 35 °C, 50, 55, 60 % R.H. 12/12 h. light dark periods).

Parameters	*A. mangiferae*			*M. mangiferae*		
	25 °C / 60 % R.H.	30 °C / 55 % R.H.	35 °C / 50 % R.H.	25 °C / 60 % R.H.	30 °C / 55 % R.H.	35 °C / 50 % R.H.
Net reproduction rate (**Ro**)	10.97	13.47	18.46	13.02	15.04	22.35
Mean generation (**T**)	21.50	17.73	17.35	18.42	16.22	16.05
Intrinsic rate of increase (**rm**)	0.111	0.146	0.168	0.139	0.167	0.193
Finite rate increase (e^{rm})	1.11	1.15	1.18	1.14	1.18	1.21
50% mortality (in days)	33	28	28	31	28	27
Number of observed females	20	21	22	19	19	21
Sex ratio (female/total)	20/30	21/30	22/30	19/30	19/30	21/30
Sex ratio (female/male)	2.00: 1	2.30: 1	2.75: 1	1.72: 1	1.72: 1	2.30: 1

The mango bud mite, Aceria mangiferae *Sayed*

Aceria mangiferae is microscopically small, cigar-shaped and whitish in color. No work has also been carried out on the its life history, except little information by Abou-Awad (1981b). It was able to develop successfully from egg to adult on only outer bracts of the terminal mango buds with cuttings of the soft terminal branches dipped into test tubes without problems. Eggs of the mango bud mite were deposited together in groups of 2 – 3 or even more that may found where the mites feed. Eggs are 34 – 38 μm in diameter, translucent, whitish, oval when the first laid, later becoming creamy-white. Embryo develops within the egg; egg turns darker, then hatched into a first instar larva which resembles the adult in many respects, but smaller, without external genitalia and with fewer annulations. The first larva is translucent, 115 – 125 μm long, not active. It passes through quiescent stage before moulting into the second instar larva, which is very much similar to the first, whitish in colour, 145 – 149 μm long, active between bracts of the buds. The second larva passes through quiescent stage before moulting and giving rise to the adult.

The total life cycle being completed in 9.68, 7.95 and 6.94 days at 25.30 and 35 °C, respectively. Males developed faster (Table 3). It is of interest to note that the moulting process was similar to that of the mango rust mite *M. mangiferae*. Insemination took place soon after female emergence from the last quiescent stage. Unfertilised females were found to produce only male offspring, while both males and females were produced by fertilised females. This in agreement with the results reported for the citrus rust mite *Phyllocoptruta oleivora* (Ashmed) and *Aculus pelekassi* Keifer (Burditt *et al.* 1963); the fig bud mite *Aceria ficus* (Cotte) (Abou-Awad *et al.* 2000) and the olive bud mite *Aceria oleae* Nalepa and the olive rust mite *Tegolophus hassani* (Keifer)(Abou-Awad *et al.* 2005).

A generation took 14.46, 10.81 and 9.47 days at least 31.21, 31.08 and 29.77 % of the generation times were spent in the egg stage. Females deposited an average of 16.92, 19.92 and 26.70 eggs (Table 3) during an oviposition period that averaged 13.06, 13.86 and 15.53 days, and then survived for 4.76, 2.85 and 2.53 days before death at the same previous temperatures, respectively. Rice and Strong (1962) reported that females of the tomato russet mite *Aculops lycopersici* (Massee), laid 10 – 53 eggs, depending on environmental conditions. It is, however, that the reproductive capacity of *A. mangiferae* might be better in favourable conditions.

A comparison of the life table parameters of the two dominant eriophyid species on mango trees (Table 4), revealed that the intrinsic rate of increase (rm) and the finite rate of increase (e^{rm}) for both *A. mangiferae* and *M. mangiferae* were almost equal, while the other parameters varied greatly, especially at 25 °C and 60 % RH and 35 °C and 50 % RH for example, the population of the mango bud mite *A. mangiferae* multiplied 10.97 and 18.46 times in a generation time of 21.50 and 17. 35 days, respectively. In regard to the mango rust mite, *M.*

mangiferae, the population increased 13.02 and 22.35 times in a generation time of 18.42 and 16.05 days, at the same previous temperatures and relative humidities, respectively. Both *M. mangiferae* and *A. mangiferae* are considered to be the most importance and injurious eriophyid species in the cultivations of mango trees, because the first is not only damages leaves by feeding, but it is also infests the vegetative buds allover the year; while the latter has been controversy regarding its role in the formation of floral and foliar galls, known as mango malformation disease (Denmark, 1983; Ochoa *et al*. 1994). However, recent studies that *A. mangiferae* does not cause mango malformation, but may play a role as carrier of the fungal pathogen *Fusarium spp*. (*F. mangiferae*, *F. sterilihyphosum* and *F. proliferatum*) which is recognized as the causal agent of mango malformation (Pinkas and Gazit 1992; Kumar and Beniwal 1992, a,b; Pena *et al.* 2005 ; Marasas *et al.* 2006).

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